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Morgan - Elevated City Railway - 1872.

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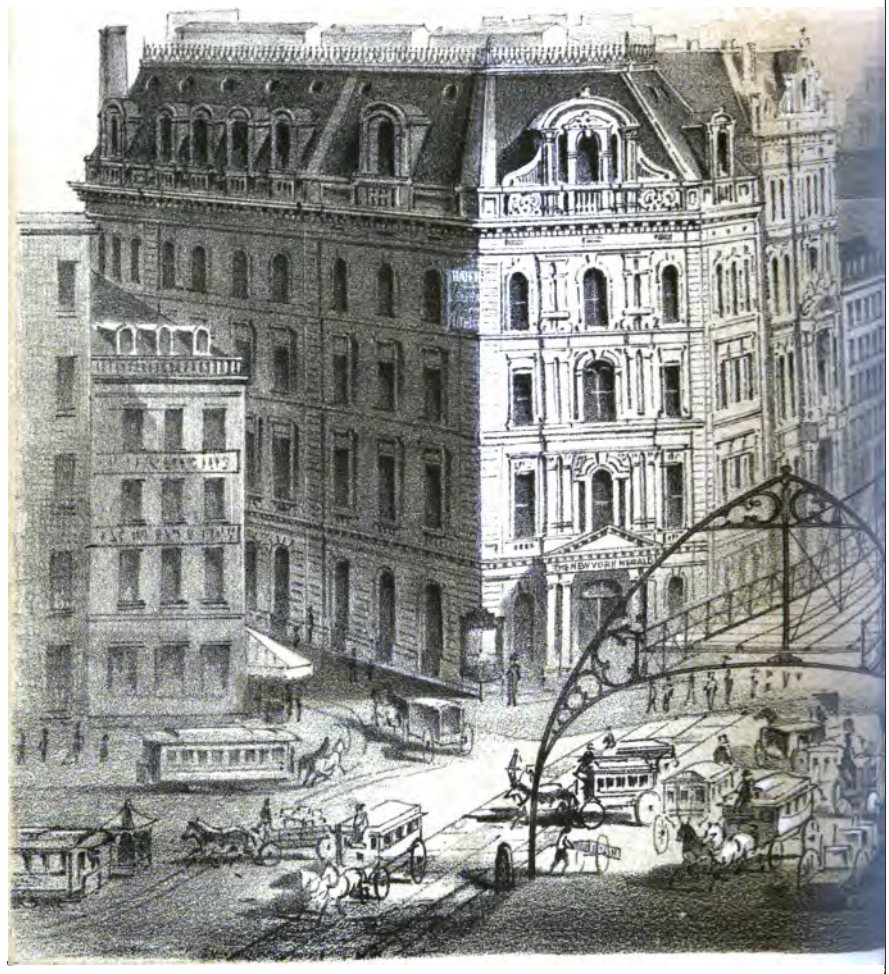

RICHD P.
Gothic Arch.

AN, JR'S.
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REPORT

ON

GOTHIC ARCH

Elevated City Railway.

BY

RICHARD P. MORGAN, Jr.,
Civil Engineer.

NEW YORK:
A. C. MACLAUCHLAN,
205-213 EAST TWELFTH STREET.
1872.

REPORT.

THE necessity for some better means of transit between the upper and lower parts of the City of New York, than any now existing, is one that has long been felt, and year by year grows more urgent. The remarkable disclosure of the census of 1870, that the growth of that city for the last decade, has been less than that of any other of the large Eastern cities, can be explained chiefly by the want of such facilities.

The ratio of increase in New York from 1850 to 1860 was $57\frac{83}{100}$ per cent., while that from 1860 to 1870 was only $13\frac{84}{100}$ per cent.

During the latter period, Brooklyn has increased $48\frac{75}{100}$ per cent., and the details of the late census show that the other suburban towns and cities near New York have increased in a high ratio. The only reasonable explanation of these facts is, that the difficulties of transit between the upper and lower parts of the island, have already become so great as to divert population in other directions—to places more convenient of access, even though far more distant than the upper parts of the city are from its business portion.

As the distances between the part of the island

used for business, and that occupied by dwellings increase, the inconvenience and loss of time caused thereby increase also; so that in the future, this want will be more and more felt, until the city ceases to grow, or till some relief is found.

Experience has shown that the use of animal power, however applied, is inadequate to meet the demand made upon it; and it is conceded that some mechanical appliance must be used. While several methods of propulsion have been suggested, there is but one that has demonstrated its utility by its use throughout the civilized world. The fact that the locomotive engine has, by reason of its greater safety, efficiency, and economy, superseded every other contrivance, for the conveyance of both persons and property on land, is conclusive proof that to it we must look for the means of transporting the vast numbers of persons moving between the different parts of New York.

For this reason, a light and perfectly enclosed locomotive is advocated, (the weight of which it is believed need not exceed five tons), though if it should be found desirable, any of the various forms of engines could be readily applied, and any of the proposed motors which may prove to be useful substitutes for steam, would be available.

In order to make the locomotive useful, it must work upon a track specially adapted to it; and this cannot be upon the surface of any street without very greatly interfering with, and indeed, even destroying its ordinary use. It follows, that any railway for the object desired, should either be, 1st, below the surface of the street; or, 2d, in a new avenue to be opened

for the railroad itself; or, 3d, elevated above the street.

It is probable that but little improvement could be made in the plans already before the public for sub-surface tracks; nor to those which contemplate the opening of a new avenue used only by the railroad. Whatever objections justly exist to either of these methods are inherent, and cannot be obviated by any change in the detail of their construction.

The natural configuration of Manhattan Island, and the existing plan of the city, point to Broadway, at least below Union Square, as perhaps the best avenue which can be used for the passage of those moving centrally between the upper and lower parts of the city; though other avenues parallel to Broadway may be used, and also the water-line around the island, thus giving vast facilities to all in New York, or to those seeking any part of the city, from the lines of transit from surrounding cities and villages.

It is well understood that many persons are reluctant to admit the necessity of any railroad in Broadway, as tending to disfigure that noble street. It is fully believed that the structure proposed, would really be ornamental rather than otherwise. But certain other considerations should not be overlooked. Cities exist as places of business; they are created as marts of commerce, and the reasonable claims of business men for the facilities which they need, have the right to be first considered. Already Broadway has ceased to be a street of residence; it has become a business avenue only; and therefore the future of that street should be considered mainly in that aspect.

If an elevated railway can be constructed of suffi-

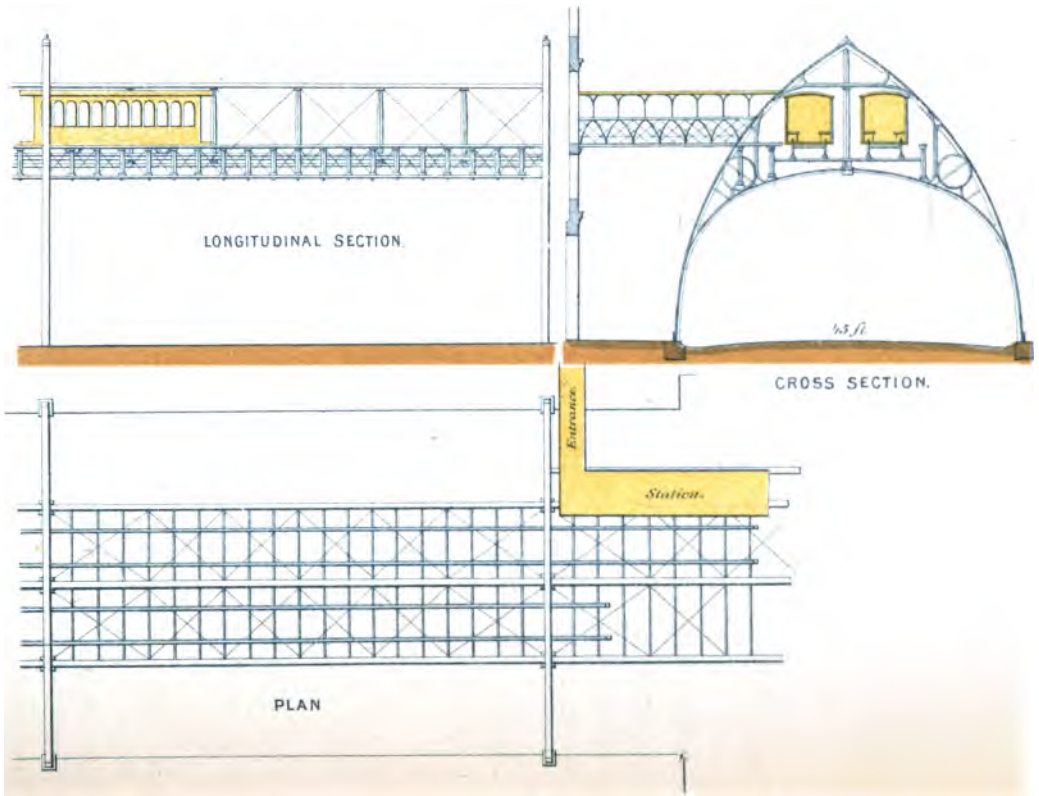
[illegible] upon a [illegible] reflection, [illegible] [illegible] [illegible] proportion in both weight and [illegible] [illegible] projects coming to and going from it, are [illegible] water. This includes not only all the foreign and coast-wise commerce, but also all the railroad transportation, except that which passes over two lines—the Hudson River and Harlem Railroads. Nature has already provided the means of cheap and rapid transit of property, as it does not exist in any other of the great cities of the world; but the very peculiarities which give this great advantage, only increase the difficulty as to the transit of persons, inasmuch as the [illegible] narrow island compels the latter to [illegible] of its surface, over great and [illegible]

creasing distances between those parts of it occupied for business and those for residences. While the plan hereafter to be described, it is believed, would be as useful in the transportation of property as any railroad not upon the surface of the ground; still, that does not seem to be the problem to be solved, nor the use for which the proposed road is mainly intended.

The design is, to set up, at suitable intervals, say about seventy-five feet, wrought-iron Gothic arches, the base of each arch or rib to be on the side-walk near the curb-stone, and the apex over the centre of the street. At such a height above the street as not to interfere with its use for ordinary purposes, a flat elliptical arch of iron is to be thrown across the street from one to the other of the arcs or ribs before mentioned. From the middle of this to the apex of the outer arch a longitudinal iron truss supports principally the tracks, aided by similar trusses on either side.

Between these outer trusses, and passing across the bottom chord of the middle one, are laid at suitable intervals, the floorbeams, also of iron, which support the tracks. These are to be connected by diagonal tension-rods, so that they shall act as a horizontal truss to prevent any lateral swaying of the structure. The whole to be left open, so as to prevent the accumulation of snow or other obstructions, and to avoid interference with the light and ventilation of the street as far as possible. The cars move over a truss-bridge above the lower, and under the outer arch. The office of these iron arches is the same as that of the piers of an ordinary bridge—to support a series of longitudinal trusses, which latter carry a double

track railway above and over the middle of the street. These arched ribs will rest upon suitable foundations of masonry beneath the surface of the street, near the curb-stone on each side, and need not, unless for architectural effect, occupy an area at the surface greater than twelve inches square. Indeed, the arches themselves may be used as supports for street lamps, thus saving the room now occupied by those lamp-posts. And a system of insulation for telegraph wires may be established upon the structure, and thus relieve the street of telegraph poles. The outer and inner arches are connected firmly by tension-rods so arranged as to resist the weight of the trusses, and of the cars in passing, and to direct the pressure of their weight into the line of the greatest strength of the material employed. Access to the cars is proposed to be given by platforms constructed of iron and glass, leading from stations provided at suitable intervals, and in which passengers can wait for the arrival of the cars. These waiting-rooms should be on both sides of the street, one for up, and one for down cars, so as to make it unnecessary for any passenger ever to cross, or even to go upon the track. If the platforms are placed opposite the cross streets, as it is desirable they should be, the light of buildings on the streets will be unaffected. The approaches to the waiting-rooms will be by staircases, placed in the buildings in which the waiting-rooms are situated. The engraved plans on the opposite page will convey a sufficiently correct idea, in connection with what has been above said, of the proposed mode of construction, though the small size of the engraving prevents all the parts from being drawn accurately to a scale;


LONGITUDINAL SECTION.
43 ft
CROSS SECTION.
Entrance
Station
PLAN

and the structure is shown as being apparently heavier than it would be in reality. The plans show a cross section of the road at one of the arched ribs; a longitudinal section from one arch to the next showing the longitudinal trusses; and a ground-plan, showing the method of supporting the tracks, and of constructing the platforms, and the space occupied by the whole structure with reference to the street beneath.

The advantages which this plan of constructing a railroad is believed to possess, are many:

1st. It is by far the most economical that has been suggested, having equal capacity.

2d. Another and most important consideration is the slight obstruction it will be to the streets during its construction. As all the parts will be prepared and fitted to each other before they are brought to their places, the structure can be very quickly put up, and during the process of erection will occupy no more of the street than is now used by the erection of new buildings. In any method of constructing an underground railroad under a street anywhere on Manhattan Island, the interference with business while the process of construction is going on must be very serious. It is obviously impossible to take up the whole or a large part of the surface of any street during the time required to excavate the necessary depth for the road, and to change the sewers, and the gas and water mains, and all their connections, and to roof over the street again by any means so as to leave beneath room for the passage of trains, without during that time nearly or quite destroying the usefulness of the street for all ordinary purposes. How much time such a work would require it is difficult to estimate;

but that it will be very considerable no one can doubt.

3d. After its completion it will not obstruct the surface of the street at all, except the small space occupied by the feet of the ribs, and this space is taken at the part of the street least in general use—at the curb-stone.

4th. The material used being entirely iron, the whole structure will be so open, as not to darken the street, or the adjacent buildings, nor interfere with their ventilation. The view will not be interfered with except in perspective up and down the street, and will not affect the lateral view of buildings on either side. Between the proposed arches, the whole structure consists of iron trusses, suspended over the middle of the street, occupying a width of about twenty-three feet at the base, and a depth of about twelve feet at the centre.

5th. The elevation of the road, and its open structure, secure it from obstruction by snow and ice, or otherwise; while the material of which it will be built, and its location in the middle of the street, avoid all danger of injury by the burning of adjacent buildings.

6th. The durability of its material, and the facility with which repairs can be made, by reason of the ready access to every part, and also being entirely unaffected by rain, frost, or snow, secure the perfection of the work, and thus insure the safety and regularity of the cars passing over it. It is easily seen that such a road as this, suitably constructed, will approach more nearly to a perfect railroad than any road yet built ever has. It will have no switches on its line

of travel to be misplaced, very slight inequality of surface or of alignment in its track, and consequently the dangers of existing railroad travel, already less than those of any other means of communication, and which are mainly due to those two causes, will be reduced to a minimum. To some persons the fact that the road is at all points considerably elevated above the ground, may suggest a fear of danger in case of accidents by which a car might be run off the track. What is stated above, shows the small risk that such an accident can occur; but even if it should, the arrangement of the structure is such, that the effect will be no greater than to a train running off a track on the level of the earth. The iron framework supporting the track will in such case uphold the cars; and the side trusses will act as a real and substantial railing, so that in no case can the cars be precipitated to the ground. These considerations also demonstrate the increased capacity of such a road over one of ordinary construction. The more nearly perfect the road, the greater the certainty with which trains can be worked upon it; and the more frequently they may safely be passed over it. It is difficult to see why trains may not follow each other at no greater intervals than may be required to check the speed of one, so as to insure the safety of that immediately preceding it. These intervals, with the light trains proposed to be employed, and their consequent small momentum, will be so short that no more than a single minute of time need be interposed, on either track, between the passage of trains, thus insuring a degree of efficiency, such as has not been in practice attained on any road yet built.

The Railway may be constructed under or after its completion, so that the plan interfere with the gas, water, sewerage or pavement of the street, nor with any work necessary in the repair or enlargement of either.

With the facility in being an intersection to Broadway, every passenger carried on this road would relieve Broadway as effectually as if carried on some other avenue, and yet no business is diverted from it; and the vast sums invested in property on this grand commercial highway remain untouched in value. It should be considered that the space proposed by this plan to be used is now vacant and unoccupied. It furnishes light and air to the buildings on either side, and nothing else. This it would still do almost as perfectly, if this new Broadway were built in what is now waste space. If constructed in the manner a work of such importance should be, and the whole structure tastefully finished, on Broadway, it remains to be shown that that which is as yet the grandest avenue, would not be made still grander. But while it is believed that the true interests of the city of New York, would be best promoted by the construction of such a road in Broadway, the plan proposed is not designed to suit only that particular locality. It is just as applicable and feasible elsewhere, as in Broadway. It may be built around the island near its water-line, or upon the streets extending up and down parallel with Broadway, with equal facility, and as is believed and claimed, with the same advantages over other plans proposed.

9th. The advantages to passengers of such a road as now proposed over any that can be built under the surface of the ground, are great and obvious. Want

of light and imperfect ventilation must of necessity be encountered in any underground railroad; and if locomotives be used as a motive power, the latter difficulty will be greatly increased by the vast quantities of deleterious gases generated by the combustion of the fuel employed, whatever that may be, and which to a serious degree will incommode, and even endanger passengers. The real extent of this objection, is shown in the report of James P. Kirkwood, C. E., on the London Underground Railway, made to the Senate Special Commission of the State of New York, Nov. 10th, 1866. Upon the road elevated, as now suggested, these difficulties are wholly avoided, and passengers are conveyed in full light and open air.

10th. The access to cars upon this road would be quite as convenient as to those of any other. Whatever road is built, must be either above or below the present surface of the ground. If upon a new avenue, still it must pass over the cross streets at such a height as not to obstruct their traffic, or in other words, must be elevated as the road now proposed. If the road should be built below the surface, the depth of the excavation must be at least as great as the height required for an elevated road, and the ascent and descent in either case will not be less than will be required in the road now proposed. Comparing an elevated road to one underground, the difference of access will be substantially that of going down cellar, or to the second story in a building; the height to ascend and descend being the same. The approaches to this road being through waiting-rooms, sheltered from storms, and entirely above the carriage-way of the streets, will be greatly more agreeable and also safer, than those to the

ordinary surface roads. The annoyance to passengers occasioned by passing over muddy crossings to reach the cars in stormy weather; and the danger from passing vehicles, are serious evils, which by the plan proposed are entirely avoided. And when reached, the cars will be more comfortable than any surface road cars can be.

Their greater size, will allow them to be warmed when necessary, and thus prevent the discomfort and exposure of health, now borne by all who enter the present street cars.

This plan has the merit of enabling its cost to be estimated in advance of its construction, with very great accuracy. Its structures are such as are already well known to engineers; and it does not require either on the one hand the acquisition of large amounts of real estate, for the opening of a new avenue, the cost of which can hardly be estimated, though known to be enormous; nor upon the other, the execution of the most difficult and expensive of all engineering work—vast underground structures, tunnels, or their equivalents.

In a city like New York, in the lower part of which such works must be constructed in loose sand, where the support of existing heavy buildings will be very difficult and hazardous, and in the upper part of which they must be excavated in solid rock, by open cut, and an artificial roof built in place of the natural roof afforded in ordinary tunnelling, the cost may be guessed at, but hardly estimated with precision.

The construction of the London Underground Railway, and its assumed success, have induced the belief that a similar road could be constructed in New York,

with equal facility. To those not acquainted with the different condition of facts existing in the two cities, such an inference is natural. London stands on a bed of very compact and tenacious clay, of great depth, and of such consistency, as to afford the greatest facilities for the execution of underground work. New York, except at its lower end, which rests on sand, stands on rock contorted in various directions, and full of seams and fissures. No tunnel, properly so called, can be built in it except at a depth below the surface to secure a roof, so great that access to it becomes nearly impracticable, and light by natural means, and ventilation, impossible; hence the justice of what is said above as to the necessity of constructing such works by open cuts, afterward to be roofed over.

It is confidently claimed, in behalf of the road here advocated, that it will be greatly more economical than any that has yet been suggested, and that it will be at least fully equal in safety and efficiency to any other; and this claim will be sustained by the estimate, in detail, as to its cost, capacity, and mode of construction.

The plan of road now presented, has been little urged upon public attention for various reasons. Before the one now offered had been devised, other plans to accomplish an end then admitted to be most desirable, and now by the census shown to be vital to the growth of the city, had been brought before the public, and their adoption strenuously urged by their respective advocates. They were principally the Central Underground Railway; the Arcade plan; the Elevated Road on posts, as partly constructed in Greenwich Street, and the "Viaduct." The first,

though it has received from the Legislature a charter such as was desired, has failed to secure public confidence so as to obtain the capital required.

The second, the Arcade, failed to obtain the charter necessary to enable any road to be built; for reasons stated in the veto message of Governor Hoffman, and which would seem to be entirely conclusive.

The road in Greenwich Street, after a large expenditure in its construction, has demonstrated serious mechanical defects and incapacity.

The "Viaduct" must fail to recommend itself as a feasible plan on account of its vast cost.

This, therefore, appears to be a suitable time to ask the attention of the public to a plan, which has at least the merits of such simplicity as will enable it to be fully understood by all, whether professional engineers or not; and also proposes no new and untried methods, but employs only old and well approved structures under new combinations.

RICHARD P. MORGAN, JR.,
Civil Engineer.

BLOOMINGTON, ILLINOIS, *January*, 1872.

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